Name _____ Class _____ Date _____

AF

Simple Qualitative Analysis

Process Objectives

- To predict which qualitative test to use in identifying an unknown ionic compound.
- To experiment with qualitative tests in distinguishing between two unknown compounds.

Learning Objective

- To become familiar with the chemistry of common ionic compounds.

Introduction

If an unknown sample is one of a limited number of possible compounds, a simple test often can be used to determine its composition. For example, a flame test (Experiment 7) can distinguish between KCl and $NaNO_3$. A drop of potassium ferricyanide solution (Experiment 8) is useful in distinguishing $FeCl_2$ from $FeCl_3$. There are hundreds of other simple "bench" tests that are useful in discriminating between a few possibilities. The alternative, sending a sample to a commercial analytical laboratory, is expensive.

Qualitative analysis is very important to the forensic chemist, one who is interested in solving crimes. The analysis used in this experiment, however, has been largely replaced with instrumentation. For example, controlled substances, such as marijuana, now can be detected in blood a week after use. Instrumental analysis can detect as little as 1×10^{-11} grams of 9-tetrahydrocannabinol (one of the active ingredients in marijuana) in 1 mL of plasma. Unfortunately, this kind of instrumentation (a gas chromatograph connected to a mass spectrograph) is expensive, costing over half a million dollars. Often times the old bench chemistry is sufficient. Certainly, a drop of hydrochloric acid is enough for the police department's forensic chemist to distinguish between a bag of cocaine and a bag of baking soda.

In this experiment you are asked to identify the contents of a number of vials. The substance in each vial is one of the two compounds listed on the label. To decide which compound is present, you will make a few simple tests.

Safety

Take the necessary precautions before beginning this experiment. Wear safety goggles, apron, and gloves. Read all safety cautions in your procedures and discuss them with your teacher. It is important to use good safety techniques while conducting experiments. See pages 8 through 11.

Apparatus

burner and tubing
1 spot plate or 3 small test tubes
2 cobalt glass plates
sparker
5-cm length of No. 24 platinum wire, sealed at the opening of a glass tube 10 cm long. If platinum wire is not available, nichrome wire (not as satisfactory as platinum) may be used. Nichrome wire should be held with forceps.

Materials

hydrochloric acid, 3 *M*
sodium hydroxide, 3 *M*
red litmus paper
filter paper, cut into short strips
sodium carbonate, solid
sodium sulfite, solid
ammonium chloride, solid
potassium permanganate, 0.1 *M*
potassium ferricyanide, 0.1 *M*
potassium ferrocyanide, 0.1 *M*

Recording Your Observations

Use your Data Table to record your observations.

CAUTION Whenever you handle acids or bases, wear safety goggles, apron, and gloves. Avoid contact with skin and eyes. Avoid breathing vapors. If any acid or base should spill on you, immediately flush the area with water and then notify your teacher.

Procedures

1. To a few crystals of sodium sulfite in a spot plate or small test tube, add two drops of 3 *M* HCl. With forceps quickly hold a strip of filter paper moistened with 0.1 *M* $KMnO_4$ over the solution. See Figure 9-1. This reaction is characteristic of the sulfite, SO_3^{2-}, ion.

Observation: _____

2. To a few crystals of sodium carbonate in a spot plate or small test tube, add two drops of 3 *M* HCl. With forceps quickly hold a small strip of filter paper, moistened with 0.1 *M* $KMnO_4$, over the solution. This reaction is characteristic of the carbonate, CO_3^{2-}, ion.

Observation: _____

3. To a few crystals of ammonium chloride in a spot plate or small test tube, add two drops of 3 *M* NaOH. Quickly, hold a piece of moistened red litmus paper *over* the solution as shown in Figure 9-2. This reaction is characteristic of the ammonium ion.

Observation: _____

4. You now have a number of simple tests: flame tests (Experiment 7), iron(II) and iron(III) tests (Experiment 8), carbonate ion test, sulfite ion test, and ammonium ion test. Use one of these simple chemical tests to identify each of the unknowns listed in the Data Table. If a solution is needed for a test, simply dissolve a small amount of the compound in water.

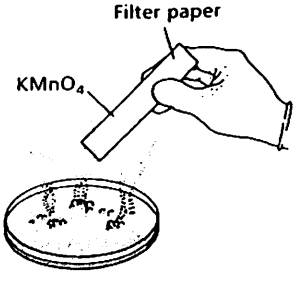

Figure 9-1

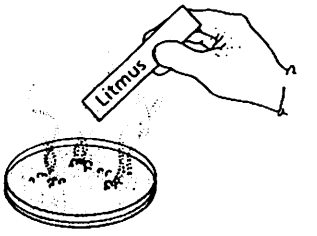

Figure 9-2

Strategy for Experimenting

The results of your tests should provide clear evidence for identifying the compounds. If you are not certain, do the test with a known compound for comparison.

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Data Table			
Possible Compounds	**Test Used**	**Observations**	**Identity**
1. KNO_3 or NaCl			
2. NH_4Cl or $MgCO_3$			
3. $FeCl_3$ or $FeCl_2$			
4. K_2SO_3 or KCl			
5. $LiNO_3$ or Na_2CO_3			
6. $Sr(NO_3)_2$ or Na_2SO_3			
7. $(NH_4)_2CO_3$ or $ZnSO_4$			
8. $BaCl_2$ or $NaNO_3$			
9. Na_2SO_3 or Na_2CO_3			
10. $Fe(NO_3)_3$ or $Zn(NO_3)_2$			

Strategy for Predicting
Consider all four ions in order to determine which test is appropriate. Review all of the tests. A useful test will give different results with each of the compounds. You should be able to predict the results for each compound before you begin the test.

Questions

1. Explain how to generate ammonia gas in the laboratory. Write and balance the equation for the reaction.

_____

_____

2. Name a salt which will give a violet color to a flame and when HCl is added will produce bubbles of gas which turn potassium permanganate brown.

_____

_____

General Conclusions

1. A few grains of an unknown white powder is brought into the crime laboratory. To identify this substance should the bench chemical tests in this experiment be used? Explain.